Solubility and Degassing Tutorial

(1) For basaltic melts that are saturated with a multicomponent H_2O-CO_2 vapor phase at 1200°C and 1 to 3 kbar pressure, calculate how dissolved H_2O and CO_2 in the melt varies as a function of pressure and the equilibrium vapor composition.

To calculate the vapor saturation isobars, assume that the vapor phase obeys the Lewis Fugacity Rule:

$$f_i = X_i f_i°$$

where f_i is the fugacity of component i (H_2O or CO_2) in the mixed vapor phase, $f_i°$ is the fugacity of pure i at the same temperature and pressure, and X_i is the mole fraction of i in the vapor phase.

Use the following solubility expressions:

$$\text{wt\% dissolved } H_2O = 0.102\, f_{H2O}^{0.5}$$

$$\text{ppm dissolved } CO_2 = 0.26\, f_{CO2}$$

The fugacities of pure H_2O and pure CO_2 are (in bars):

Pressure	1000	2000	3000
H_2O	993	2034	3197
CO_2	1248	3146	5979

Show your results for the three different pressures on a graph with dissolved H_2O (in wt.%) on the horizontal axis and dissolved CO_2 (in ppm) on the vertical axis.

Use your results to show isopleths (lines of constant vapor composition) for mole fractions of CO_2 in the vapor phase of 0.9, 0.5, and 0.1.

(2) Use SolEx to calculate the degassing of dissolved volatiles (H_2O, CO_2, S, Cl) from a mafic melt during decompression as the melt ascends to the surface. You can use the default values for melt composition and dissolved volatile contents. Run simulations using both open- and closed-system degassing. During open-system degassing, the vapor phase is continuously separated from the melt, whereas during closed-system degassing, the vapor remains in equilibrium with the melt.

Make graphs of:
1. pressure vs. molar CO_2/H_2O ratio in the gas
2. mass ratio of dissolved CO_2/H_2O in the melt vs. molar CO_2/H_2O ratio in the gas
3. pressure vs. molar CO_2/S in the gas

Compare your results to the high-temperature fumarolic gas compositions from Fischer (2008). What insight does this give you to the pressures at which fumarolic gases were released from, or last equilibrated with, magma?